EEE 313 - Electronic Circuit Design - Lab 3 Experimental Report
Tuna Şahin - Class-B Push-Pull Power Amplifier

Preliminary Recap:

In our preliminary report, we were asked to implement a class-B power amplifier circuit with the help of a complementary BJT setup. While implementing this, we had some criteria that we had to satisfy.

Specifications:
1. The amplifier should deliver at least 0.95W power to a 33Ω resistance (16Vpp to a 33Ω power resistor) at 1KHz with the chosen gain value.
2. The harmonics (the highest is possibly the third harmonic) at the 0.95W output power level should be at least 40 dB lower than the fundamental signal at 1 KHz.
3. The power consumption at quiescent conditions should be less than 500mW.
4. The amplifier's efficiency (output power/total supply power) should be at least 40% at max power output (0.95W) at 1KHz.
5. The −3dB bandwidth of the amplifier should be at least 150Hz to 15KHz.

Component List:

- 3 x 10μF Capacitors
- 1 x 220μF Capacitor
- 2 x 1Ω Resistors
- 2 x 10kΩ Resistors
- 2 x 1.5kΩ Resistors
- 1 x 27Ω Resistor
- 1 x 2.7kΩ Resistor
- 1 x 27kΩ Resistor
- 1 x 11W, 33Ω Power Resistor
- 1 x 39kΩ Resistor
- 1 x 470kΩ Resistor
- 1 x 5.6kΩ Resistor
- 1 x BC238 NPN BJT
- 1 x BC307 PNP BJT
- 1 x BD135 NPN BJT
- 1 x BD136 PNP BJT
- 1 x LM358 Dual Opamp

Hardware Implementation:

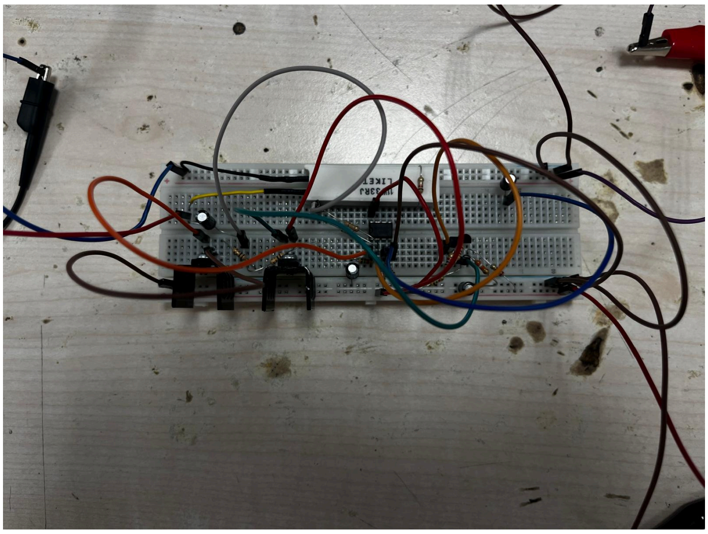


Figure 1: Hardware Implementation of the Circuit

Measurements:

For all of these measurements $v_{in} = 0.9V$ peak-to-peak.

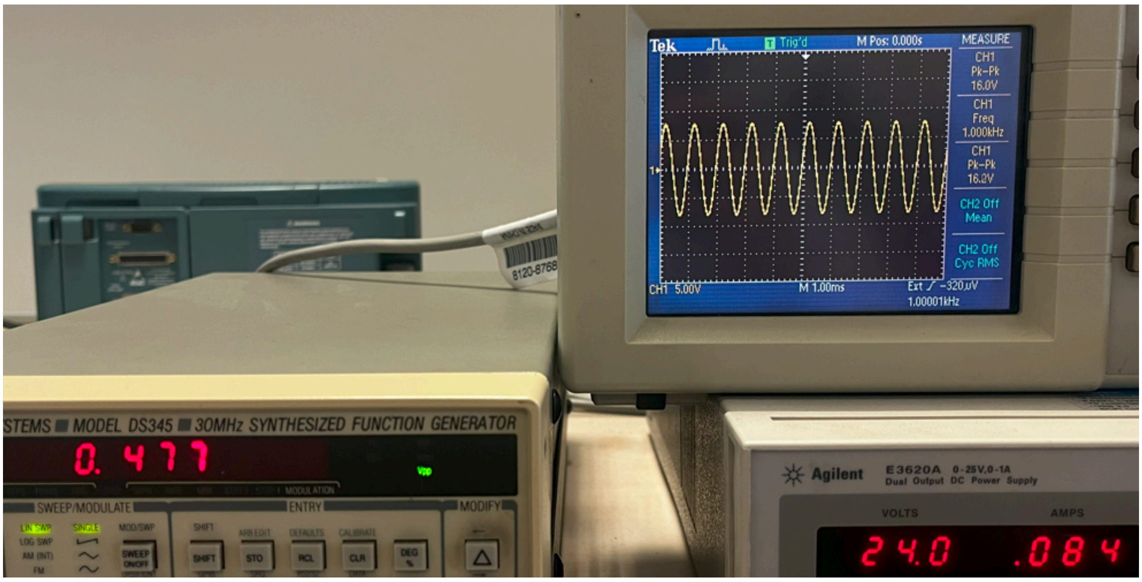


Figure 2.1: Voltage of the Load Resistor

A 17V peak-to-peak sinusoidal can be observed on the Load Resistor. Therefore, the total power dissipated by the load is: $\frac{1}{2}\frac{64}{33} = 1.094W$ Gain is: $20log_{10}(\frac{16}{0.9}) \simeq 25dB$

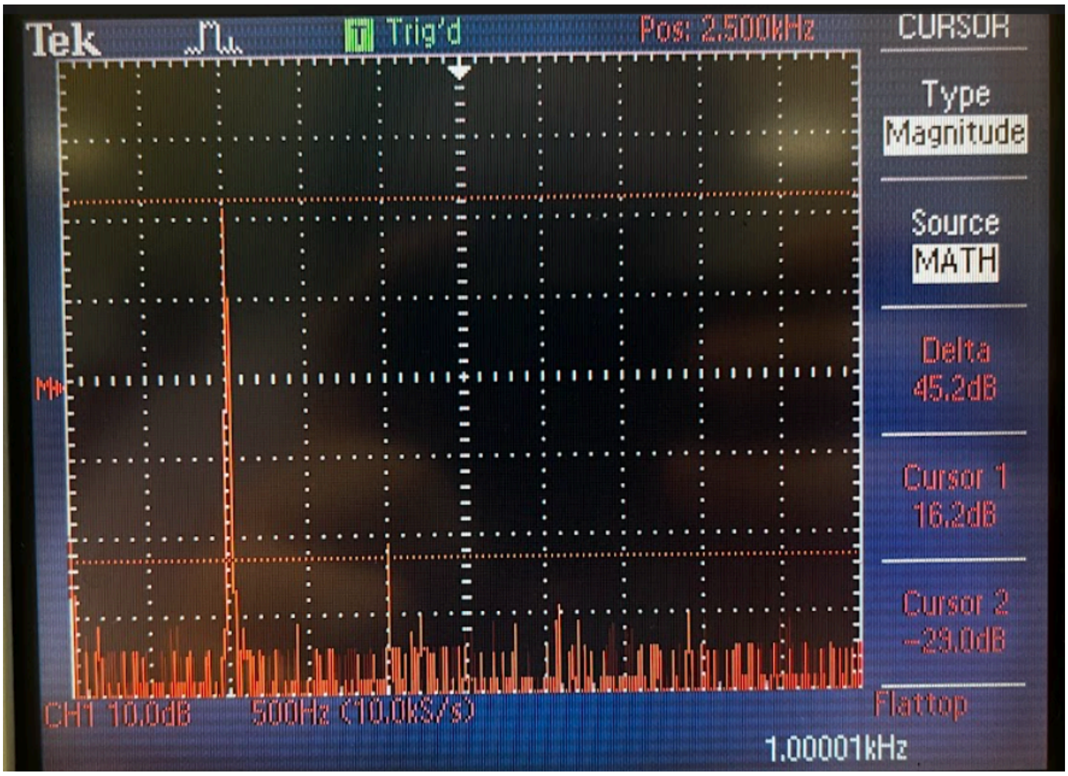


Figure 2.2: FFT of V_{out}

The difference between the fundamental harmonic and the second harmonic can be observed to be 44.8dB.

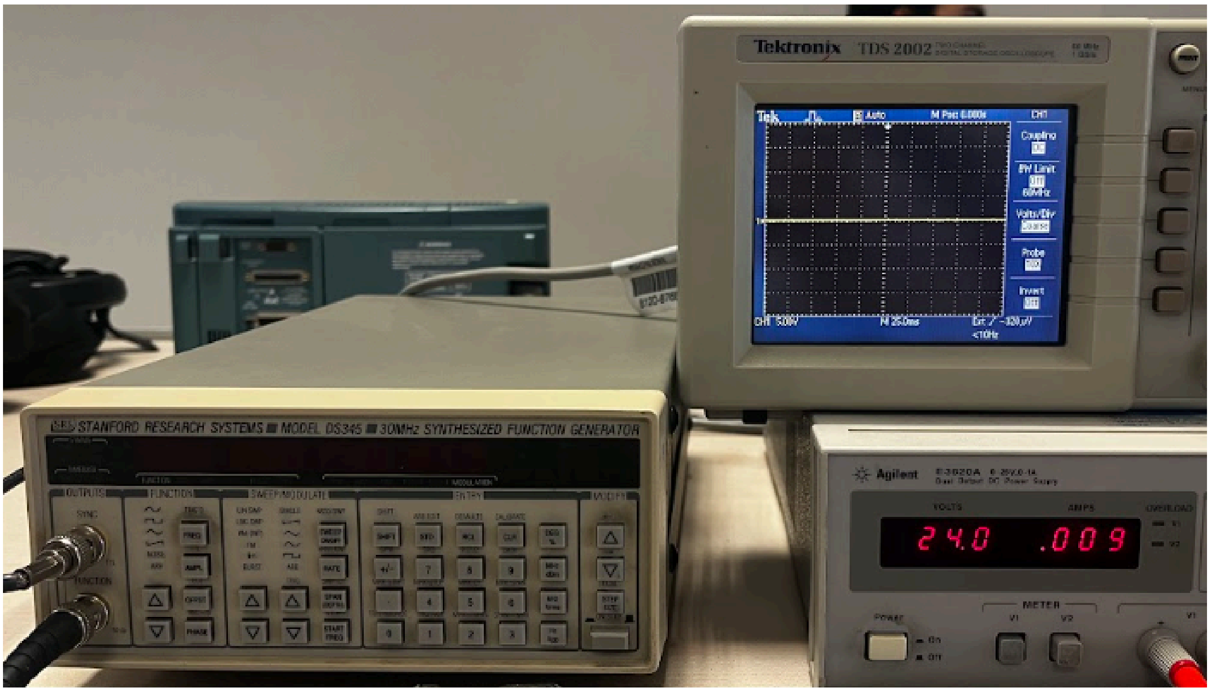


Figure 2.3: Power Source Values at Quiescent Point

The signal generator is turned off, hence, $v_{in} = 0$. The source has a current of 9mA at Quiescent Point. That makes the source power: $24 \times 0.009 \simeq 0.2W$

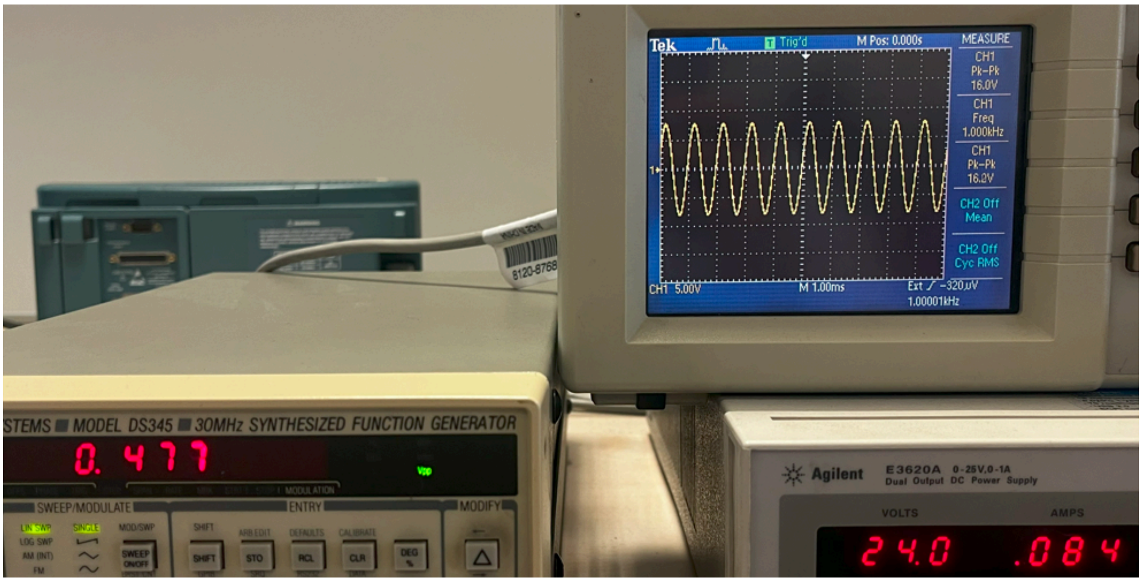


Figure 2.4: Load and Source Power

We can calculate the load Power as: 0.96W and the source power as: 2.016W
Which would make our efficiency: 0.47 or 47%

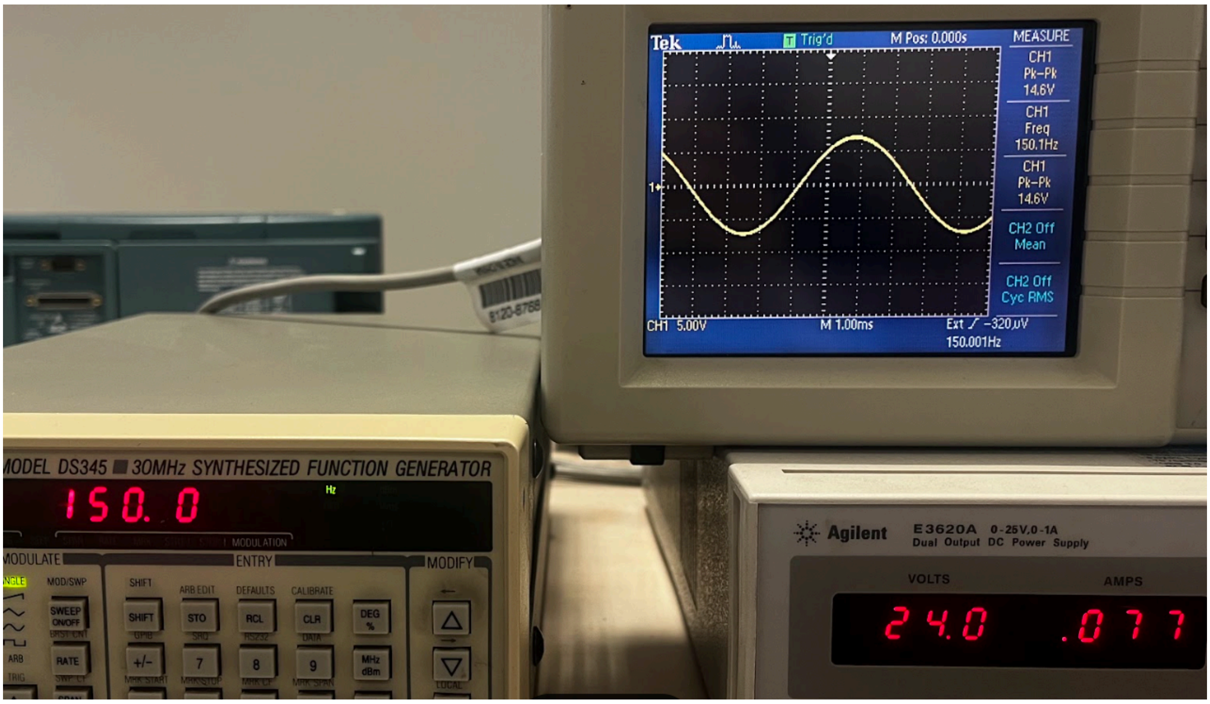


Figure 2.5.1: Load Voltage at 150Hz

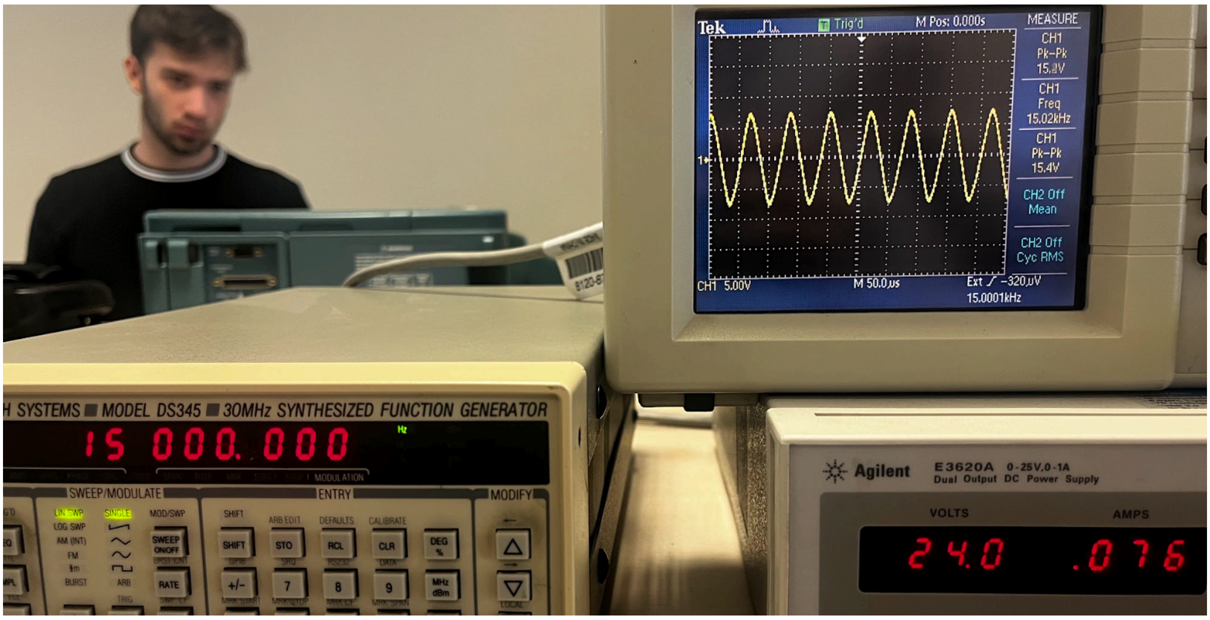


Figure 2.5.2: Load Voltage at 15kHz

The amplitude at 150Hz is: 14.8V The amplitude at 15kHz is: 15.6V
Therefore their respective gains are: 23.4dB and 23.8dB. Both are in the -3dB range.

Plots and Tables:

v_{in}	i_{Vcc}	V_{out}	P_{in}	P_{out}	$P_{out}/P_{in} = \eta$
0.1	24mA	3.16V	0.576	0.037	6.42%
0.2	39mA	6.16V	0.936	0.143	15.2%
0.3	54mA	9.36V	1.296	0.331	25.5%
0.4	71mA	12.9V	1.704	0.630	36.9%
0.5	87mA	16.1V	2.088	0.981	46.9%
0.6	102mA	19.6V	2.448	1.455	59.4%

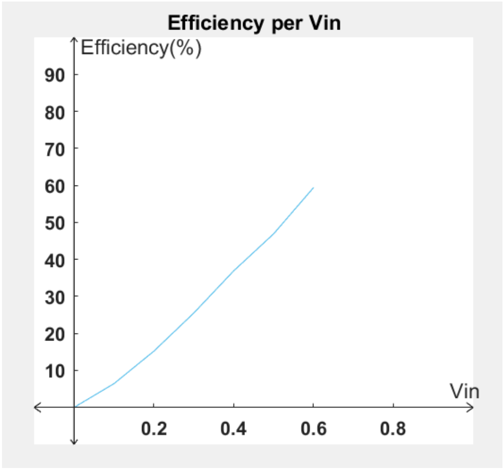


Table 1: Efficiency as a function of v_{in}

Figure 3.1:Efficiency as a function of v_{in}

The respective pictures of the measurements in Table 1 are located in Appendix A.

f	v_{in} (amplitude)	V_{out} (amplitude)	Gain (dB)
100Hz	0.5V	7V	22.92
150Hz	0.5V	7.5V	23.5
500Hz	0.5V	8.3V	24.4
1kHz	0.5V	8.4V	24.5
2.5kHz	0.5V	8.2V	24.3
5kHz	0.5V	8.2V	24.3
7.5kHz	0.5V	8.1V	24.2
10kHz	0.5V	8.1V	24.2
12.5kHz	0.5V	7.8V	23.86
15kHz	0.5V	7.5V	23.5
21kHz	0.5V	6.3V	22

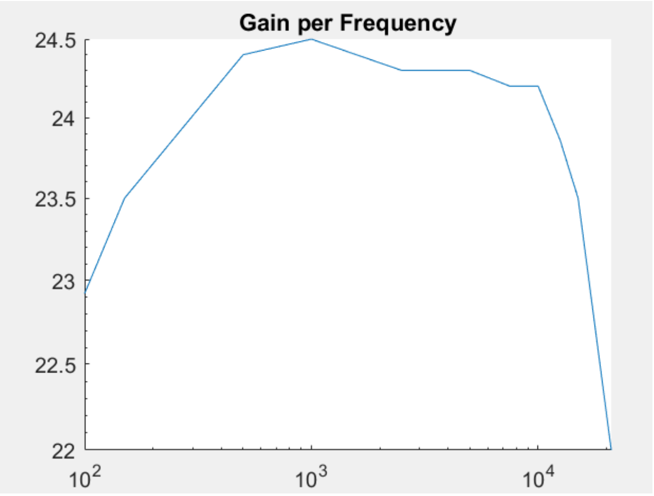


Table 2: Gain as a function of f

Figure 3.2: Gain as a function of f

The respective pictures of the measurements in Table 2 are located in Appendix B.

Appendix A:

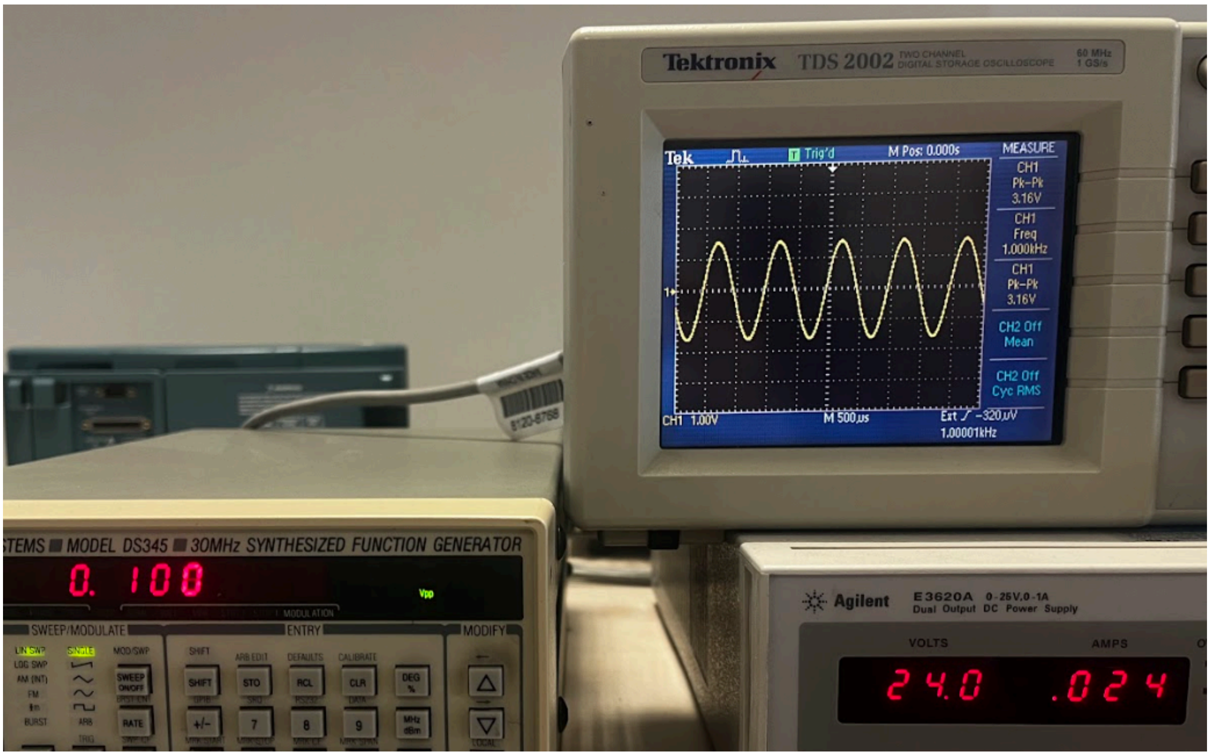


Figure A.1: Measurement at $v_{in} = 0.1V$

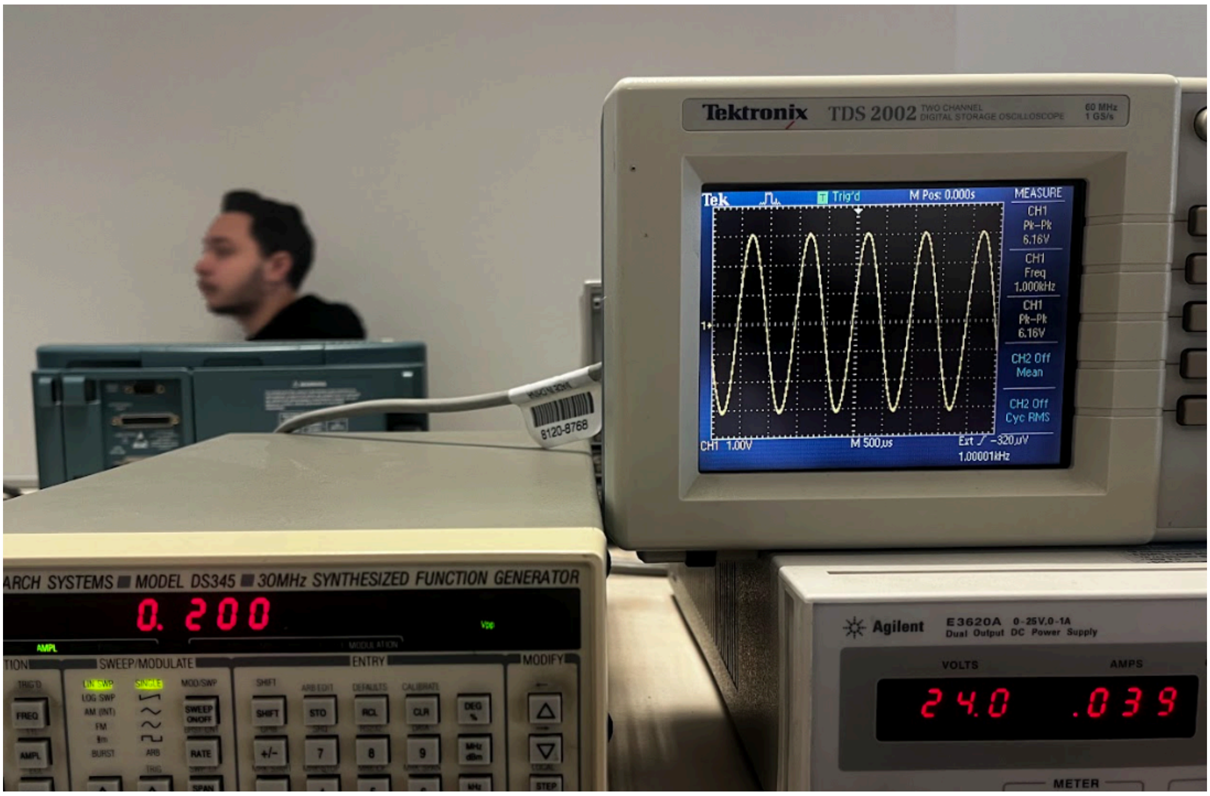


Figure A.2: Measurement at $v_{in} = 0.2V$

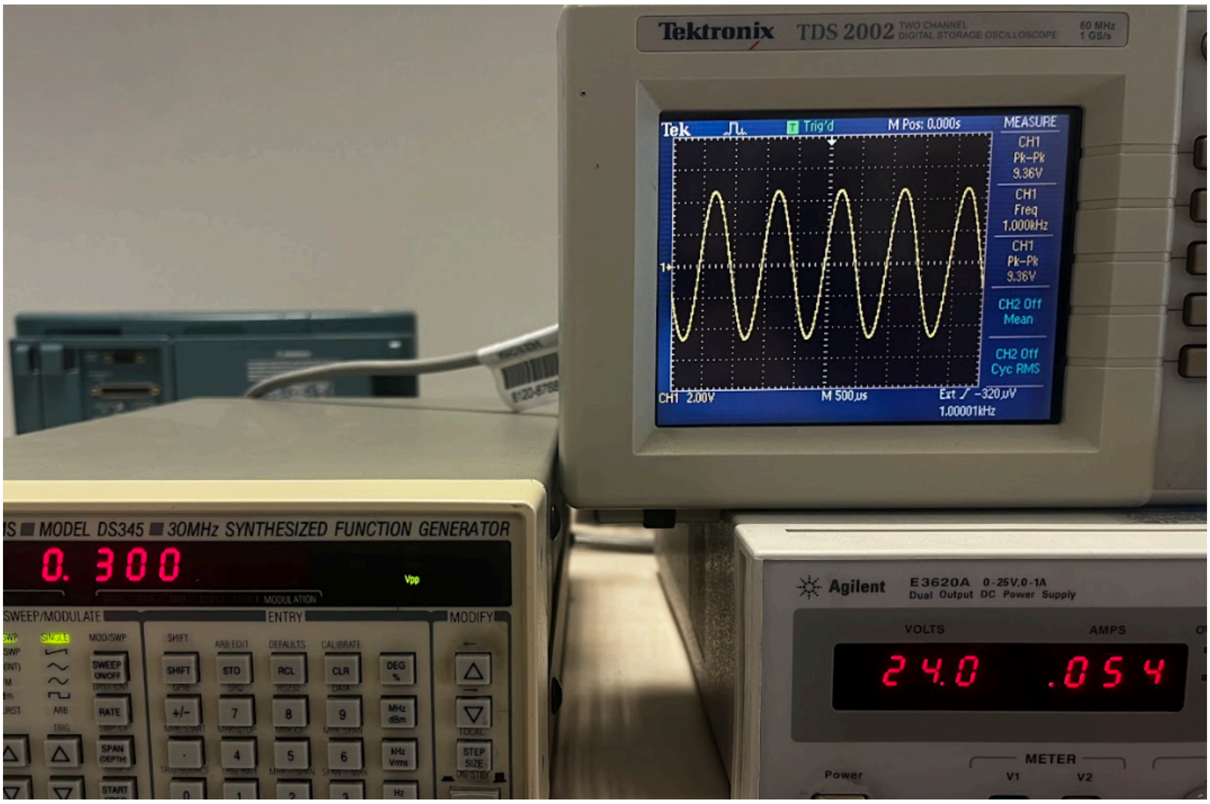


Figure A.3: Measurement at $v_{in} = 0.3V$

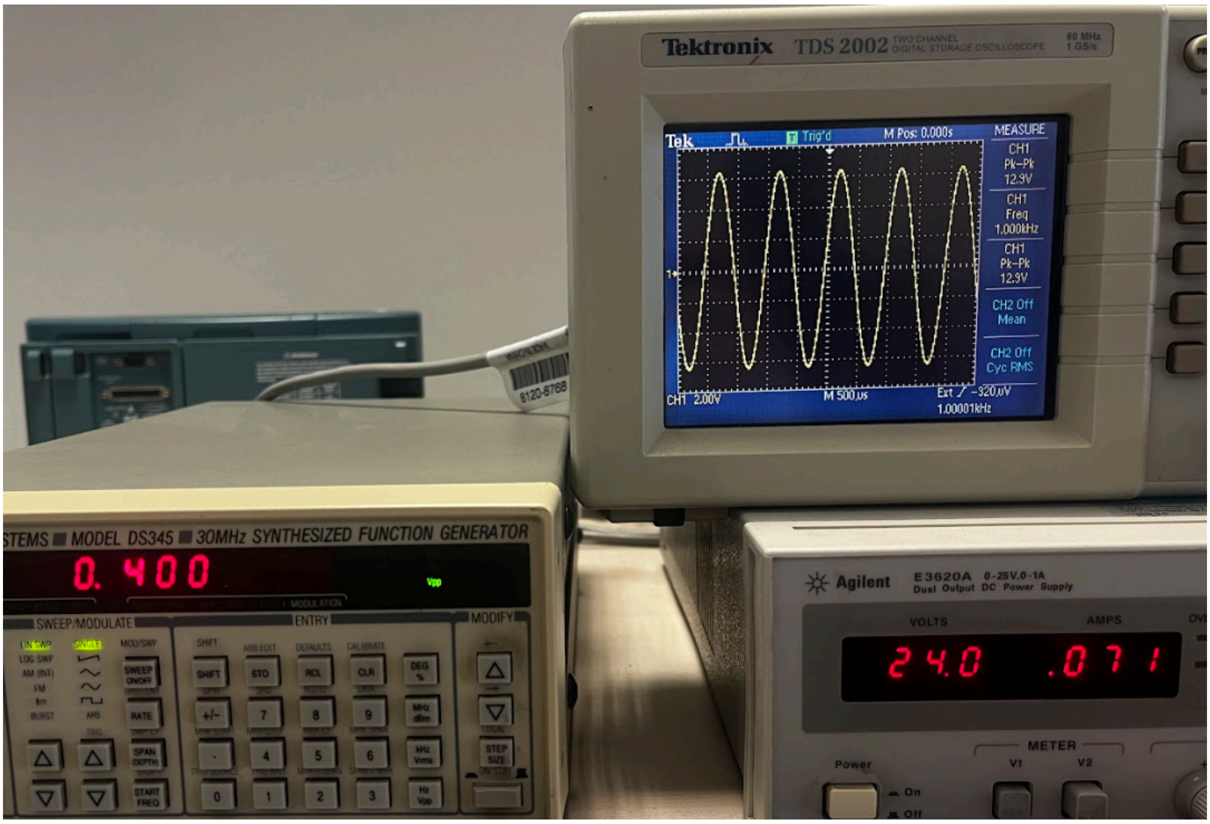


Figure A.4: Measurement at $v_{in} = 0.4V$

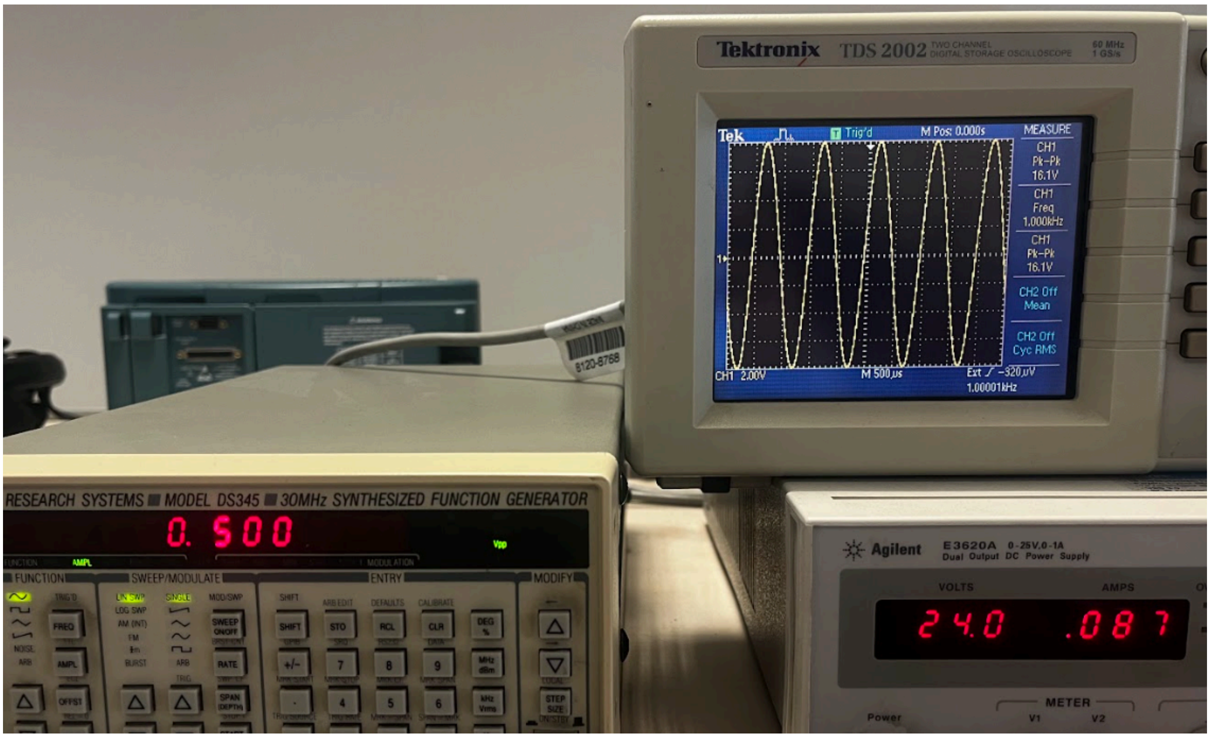


Figure A.5: Measurement at $v_{in} = 0.5V$

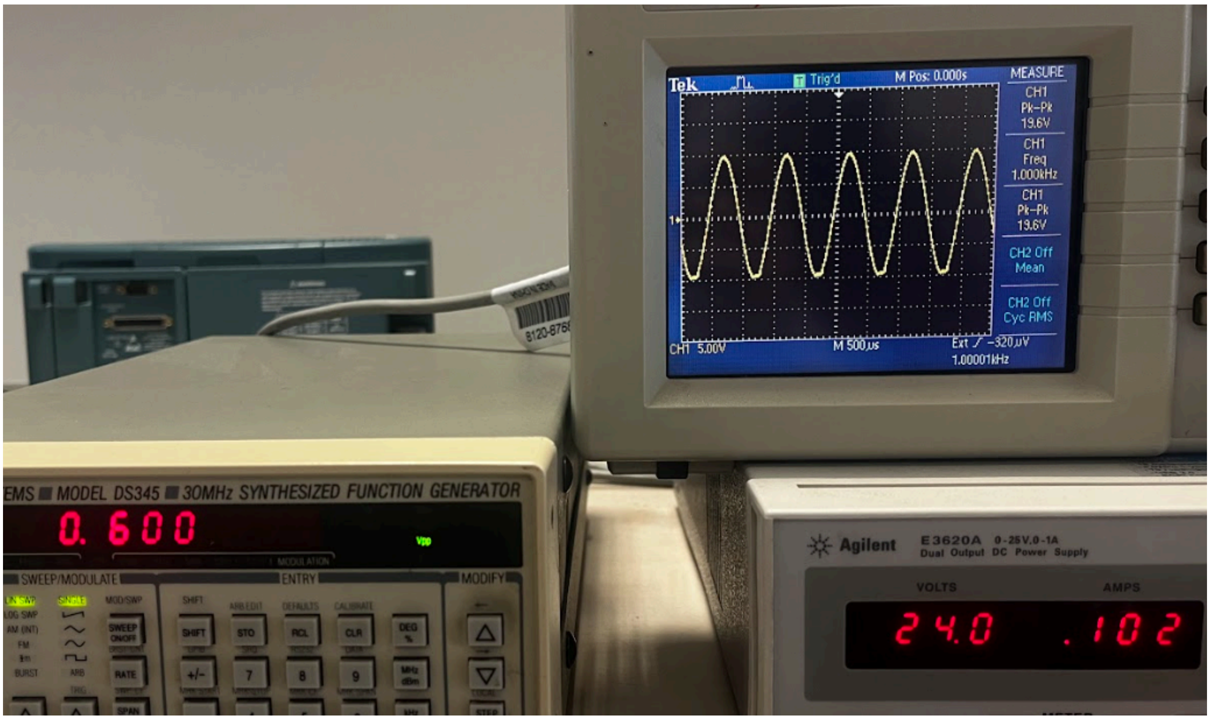


Figure A.6: Measurement at $v_{in} = 0.6V$

Appendix B:

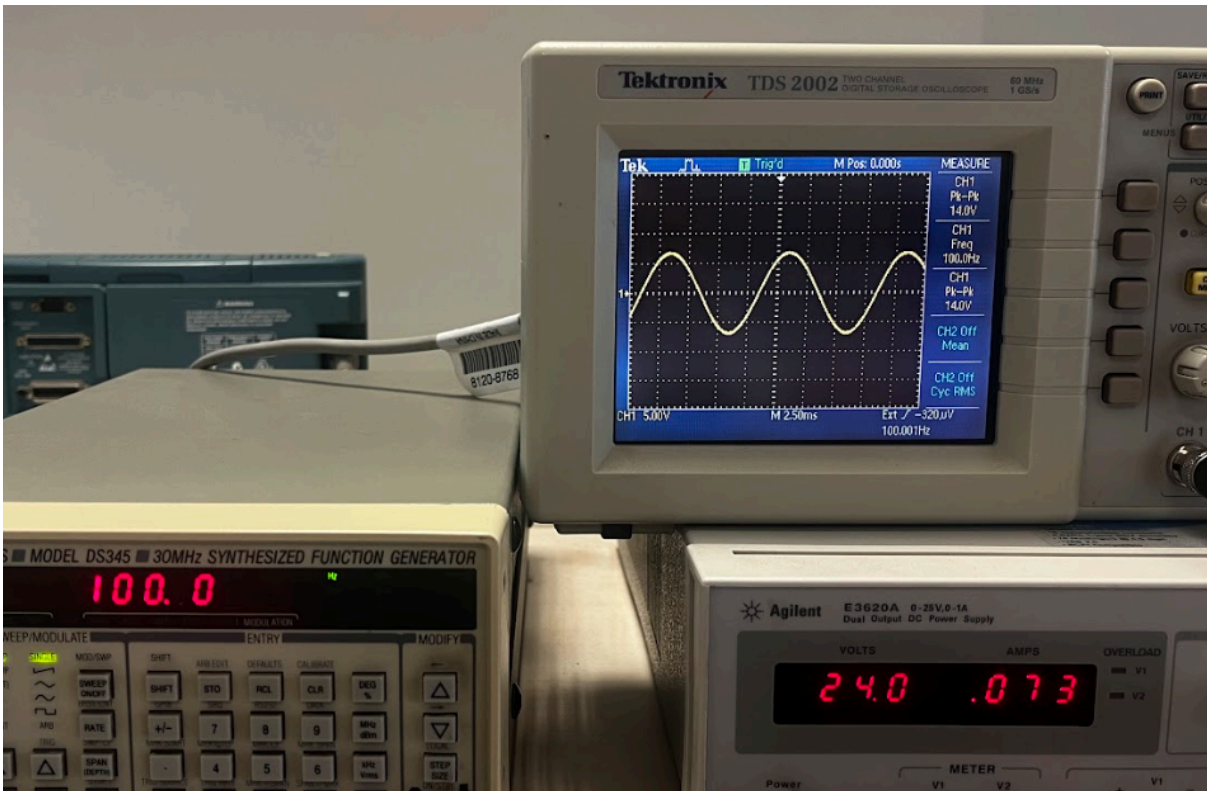


Figure B.1: Measurement at 100Hz

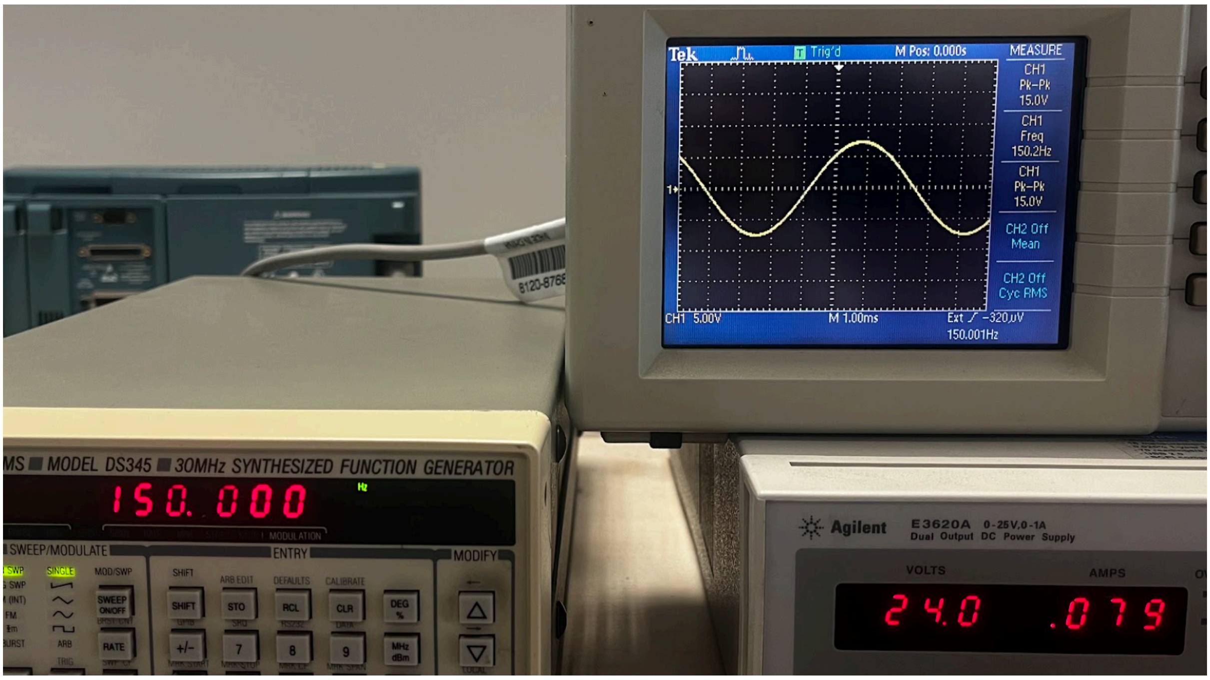


Figure B.2: Measurement at 150Hz

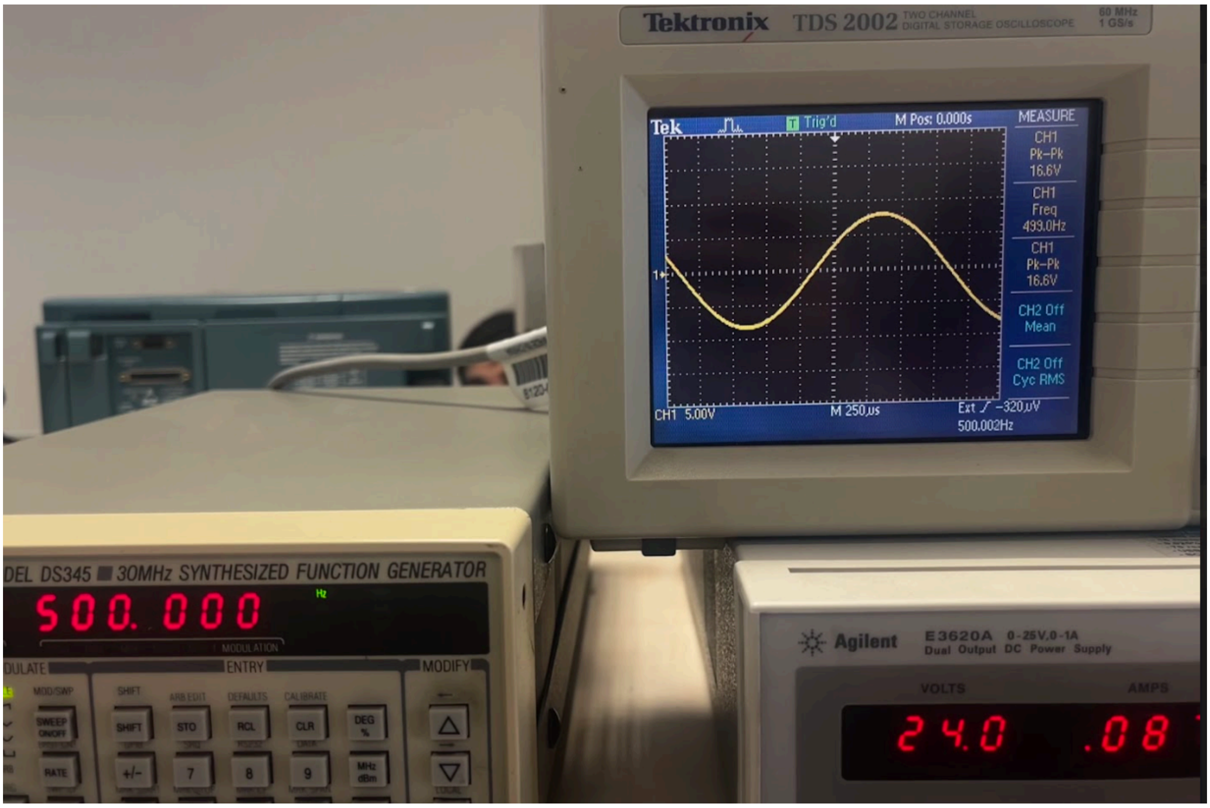


Figure B.3: Measurement at 500Hz

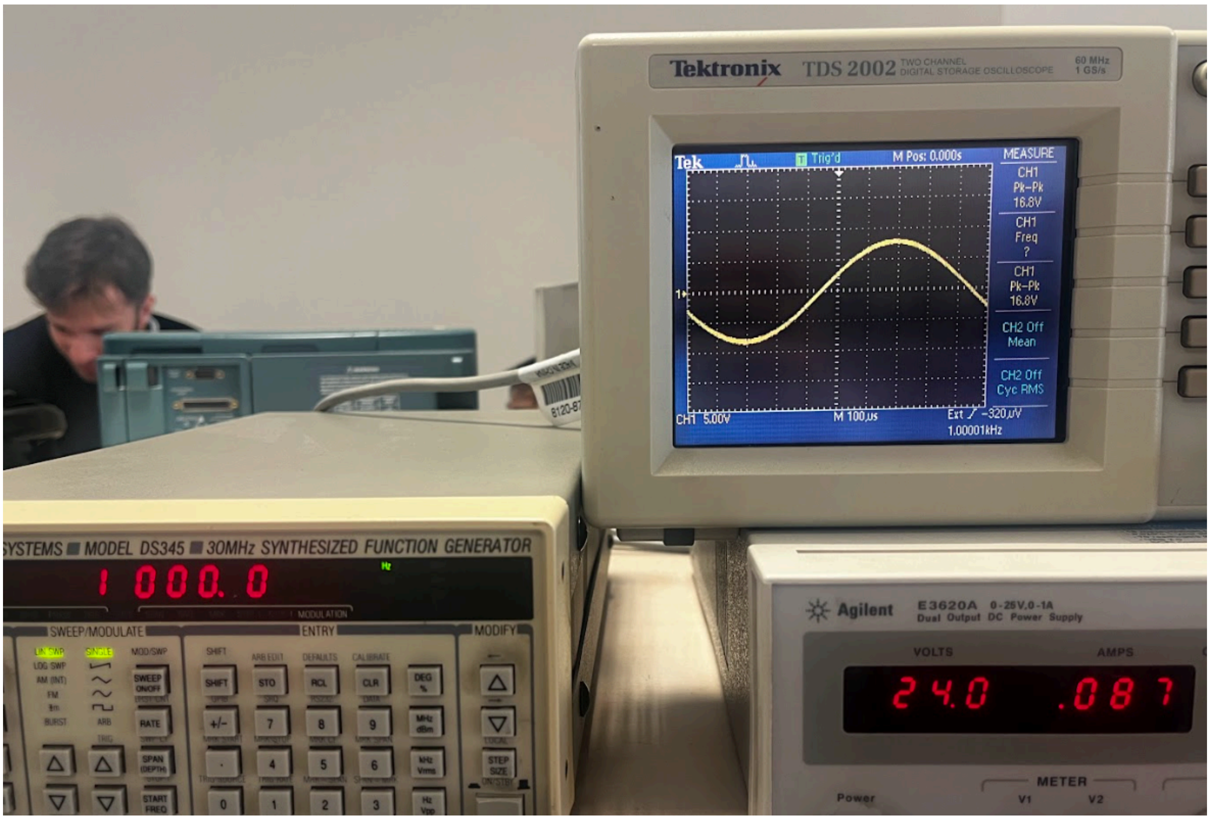


Figure B.4: Measurement at 1kHz

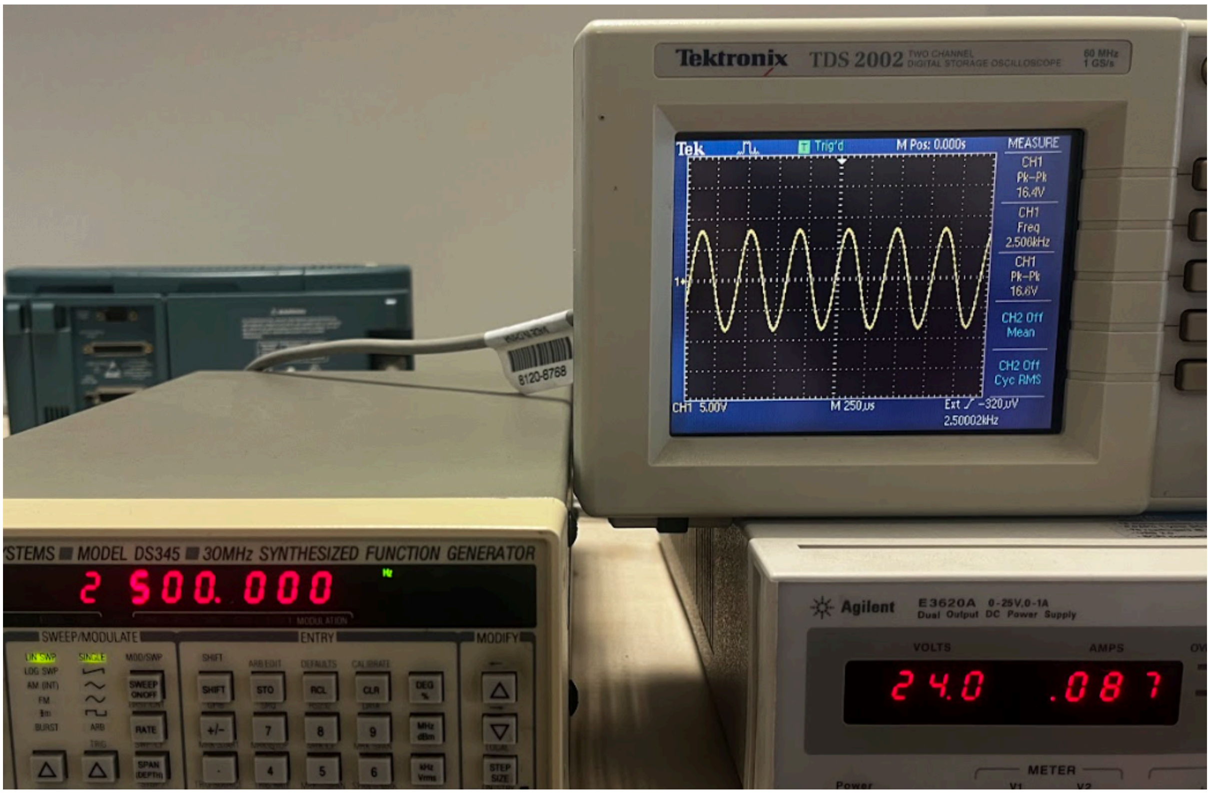


Figure B.5: Measurement at 2.5kHz

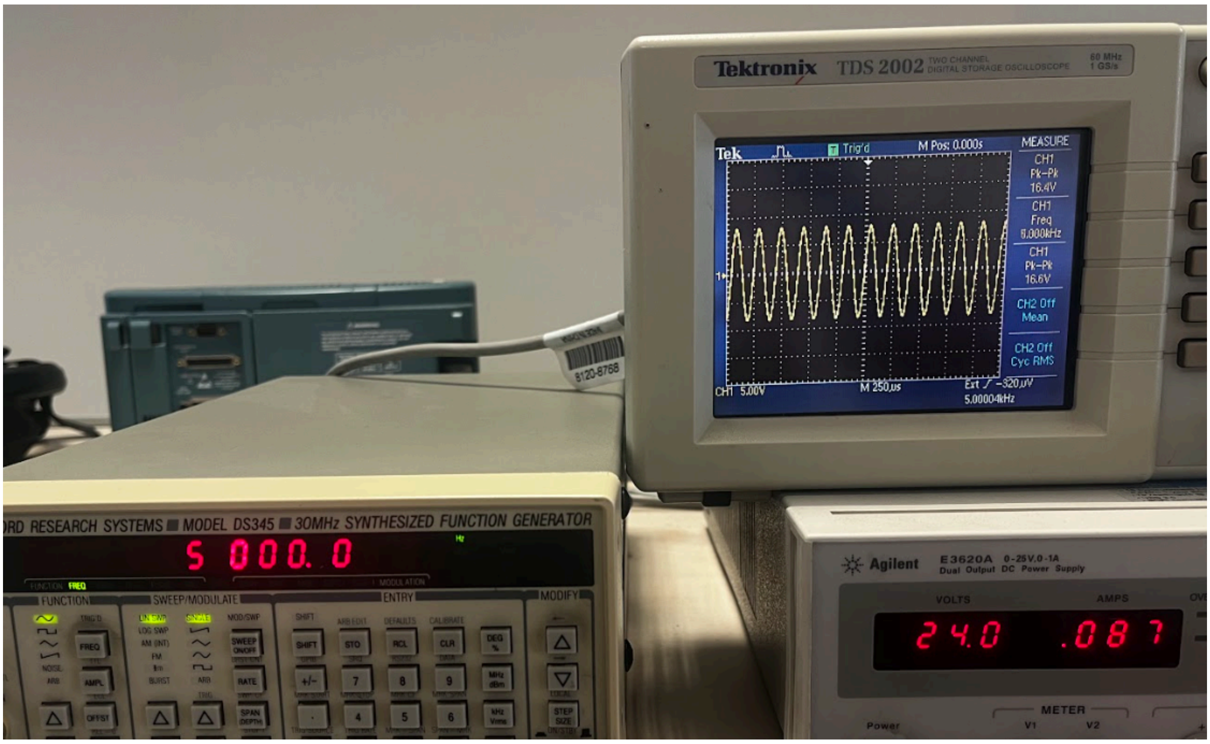


Figure B.6: Measurement at 5kHz

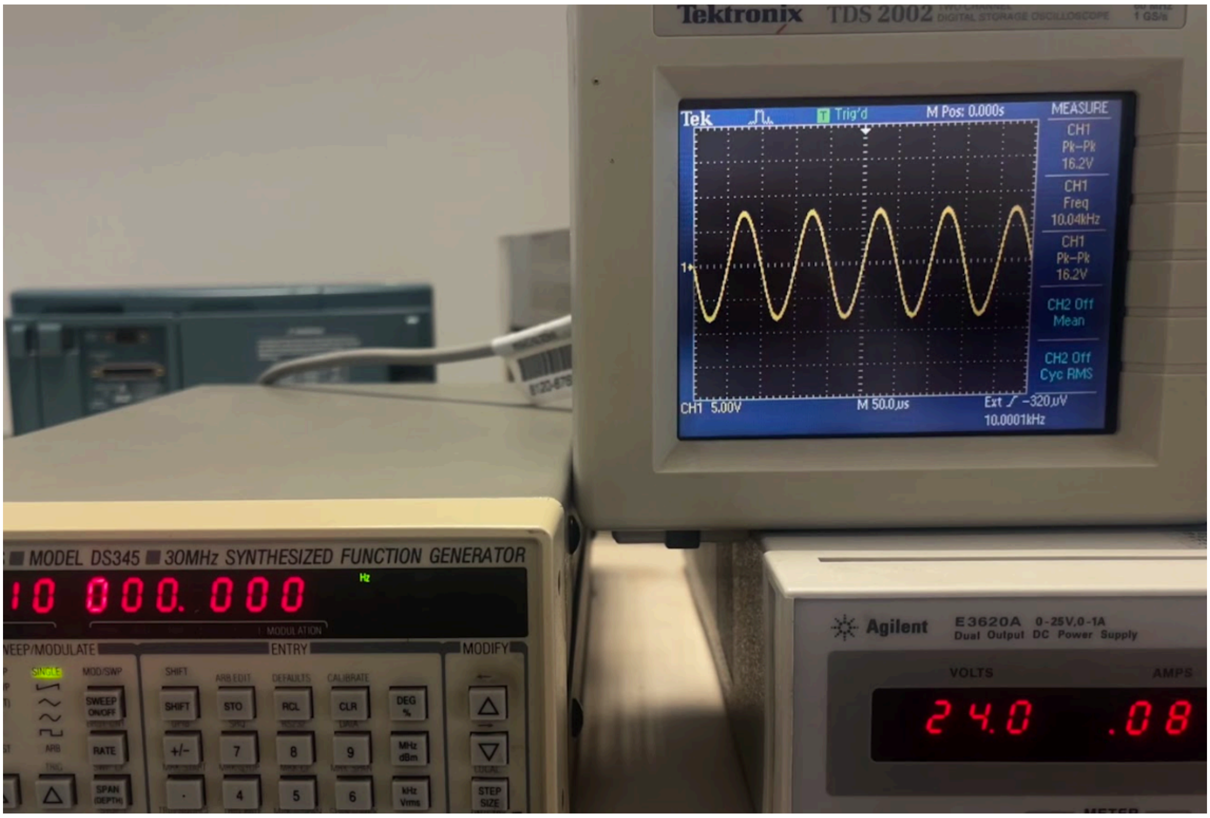
Figure B.7: Measurement at 7.5kHz


Figure B.8: Measurement at 10kHz

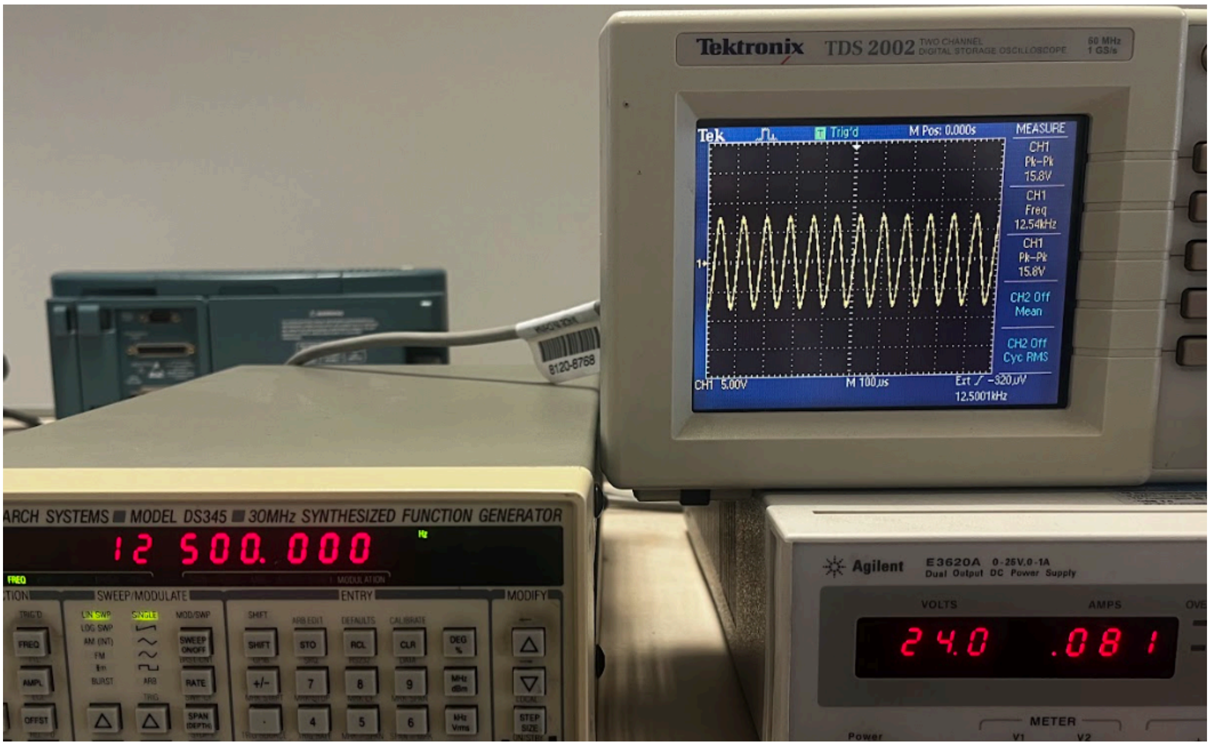


Figure B.9: Measurement at 12.5kHz

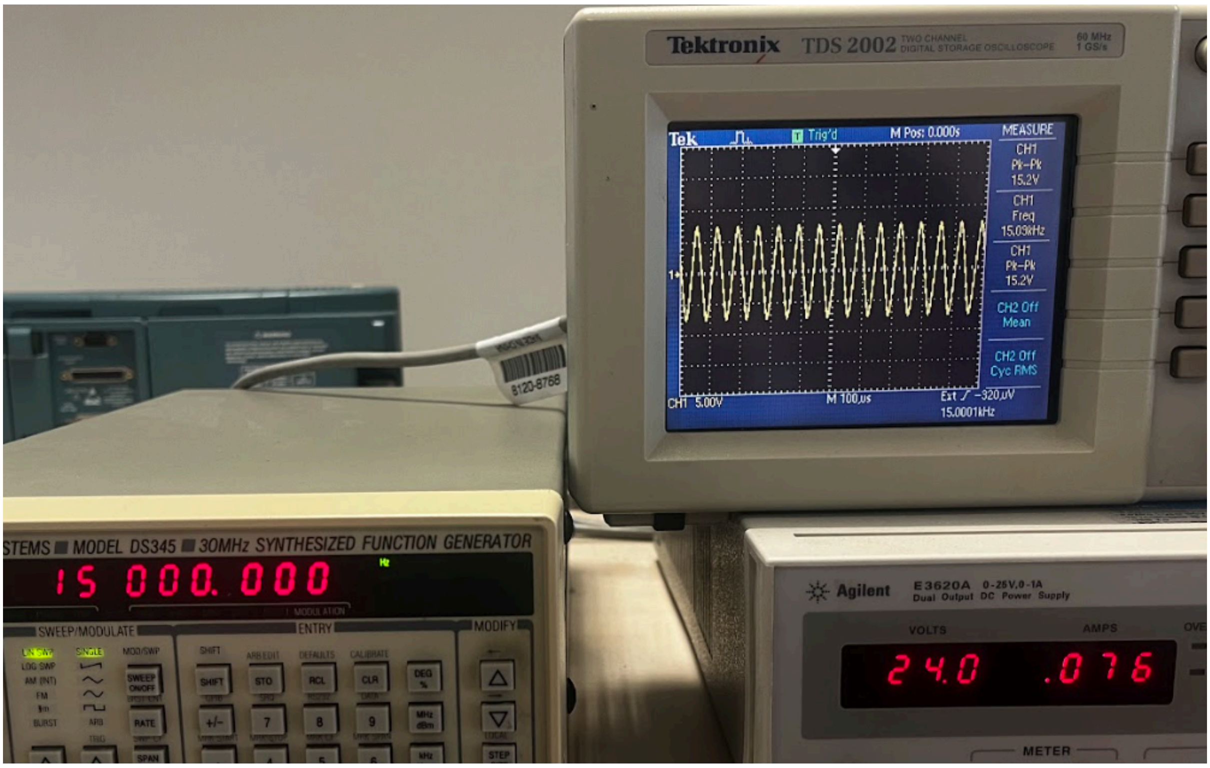


Figure B.10: Measurement at 15kHz

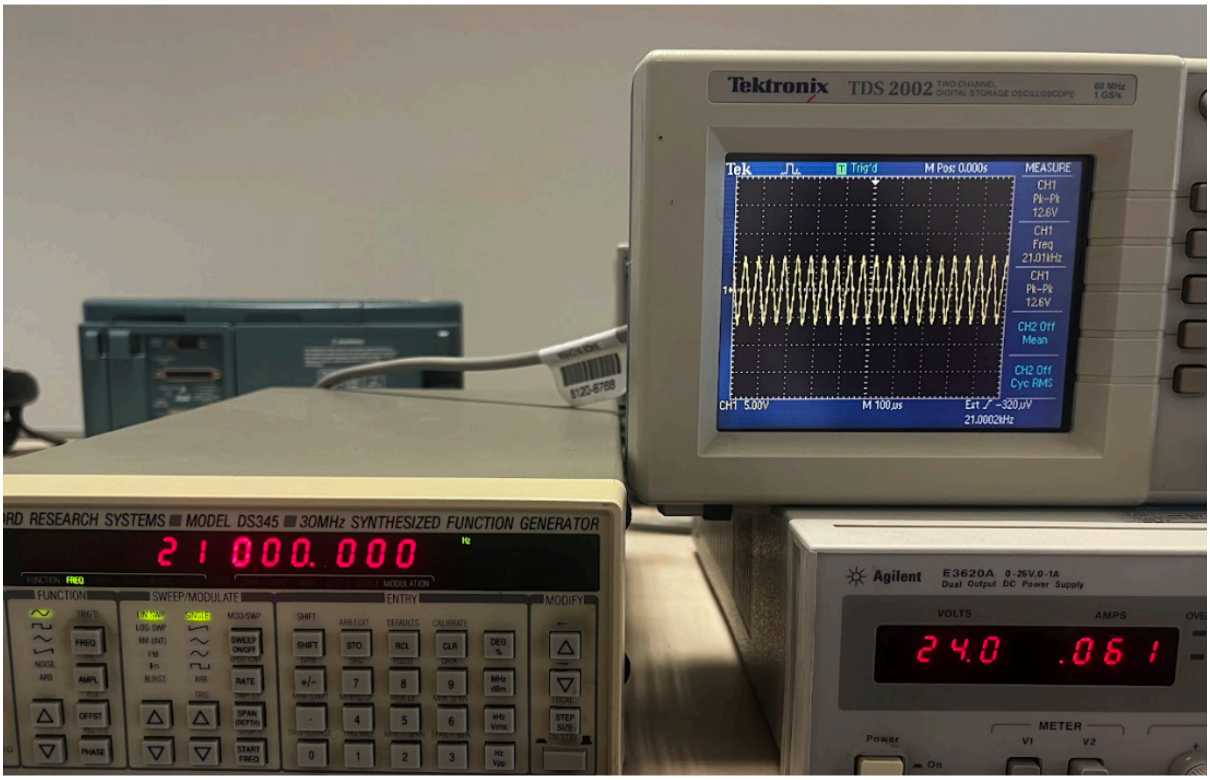


Figure B.11: Measurement at 21kHz